remark is called for, is the proof of the permanence of the velocity potential. Mr. Lamb has offered a proof of this now historic theorem, which, if judged by the space it occupies, should be much simpler than the acknowledged proceric of auchy and Stokes. As no authority is cited, it as it appear that this proof is here given for the first time. If so, the author has done himself great injustice in not examining or explaining his reasoning more closely. For, as it stands, it suggests the idea that he has ignored the fact that dx, dy, dz on the left of his equation, are integrals through a finite time, and hence, inasmuch as he has given no reason to the contrary, may be of a different order of magnitude from their initial values, da, db, dc, which appear on the right of his equation. If this is not so, it is a peculiarity of the motion of continuous fluid, and needs establishing, otherwise we might infer that two people who had once shaken hands could never after be so much as a mile apart. If this proof is found to be unsound, it is an unnecessary blemish in the book, for even if true, it would not replace the more elaborate, but much more physically instructive, proofs given by Stokes and Thomson, which the author has given further on in the book.

These remarks only carry us into the second chapter. The rest of the book, with the exception of the last chapter, is devoted to the account of what has been done in the way of integrating the equations of motion, and this may be taken as the purpose of the book.

This part of the theory, which is now very extensive, has almost all been developed within the last fifty years, and most of it within a much shorter period. It is the work of the very ablest mathematician, and is of the highest and most difficult kind, and in general incomplete. It was only to be found in isolated memoirs in various languages. The collecting, abbreviating, and arranging this into a systematic treatise has been no ordinary task, and the result shows that, in addition to his mathematical power, the author must possess the gift of compiling. One of the most striking features of the book, considering the variety of sources from which the matter was collected, is the uniformity of the notation. There is, however, one departure from this which is important, although evidently an oversight. The term *stream-lines*, carefully defined in Art. 28, as applicable only to steady motion, is freely used throughout the book in the sense of *lines of motion*, as applied to cases in which the motion is not steady.

The advance which has been made of late years has not been by the discovery of any general method of integrating the equations of motion, but by the discovery of certain general relations between the motion within certain regions of space, and the shape and motion of the boundaries to those regions. The steps in the discovery of these kinematical relations are principally due to Green, Stokes, and Helmholtz, but they have been generalised and elaborated by Thomson and Maxwell, and to these latter the present method of expression is due. An extremely lucid account of these relations is given in Chapter III., by which the author has cleared his ground for the treatment of such integrations as have been effected. These comprise many cases of steady flow, the method being that of the stream-line function first given by Stokes, but afterwards reduced to a geometrical form by Maxwell, and largely applied by Rankine. They also comprise cases of vortex motion treated by Helmholtz's well-known method, and the theory of waves, as worked out principally by Stokes, Green, and Rankine. Only one chapter of the book is devoted to elastic fluids, and this, under the shadow of Lord Rayleigh's complete work, does not call for special comment.

The last chapter is on viscosity, and is taken from Prof. Stokes's paper on this part of the subject. Although this paper has been published thirty-three years, this is the first treatise in which any adequate account of its very important contents has appeared in a general treatise.

Throughout the book the various steps are carefully ascribed to their different authors, a very difficult task, and one in which the author appears to have been generally successful. There are, however, two instances of failure which call for notice. Equation 10, Art. 29, is known by modern French writers as Bernoulli's theorem ("Théorème de Daniel Bernoulli, Bresse," vol. ii. p. 25). Example 11, Art. 97—The fact that the contraction from a canal projecting inwards is $\frac{1}{2}$ was proved long ago and the results verified by Borda.

In respect of diagrams Mr. Lamb's book might certainly have been improved. The great difficulty in the study of the subject is to obtain a conception of the lines of motion, and in this, diagrams such as those given by Rankine, Maxwell, and Sir William Thomson, are invaluable. The graphic method of obtaining the lines of motion developed by Maxwell and Rankine, has led to most important steps, but without diagrams it is as impossible to form a conception of this method, as of the lines of motion themselves.

The omission in this respect, as well as a tendency to reduce verbal explanations, would have shown without the examples at the end of the volume, that the author has been influenced by a desire to adapt the book to the requirements of the mathematical tripos, in which desire he has certainly succeeded. Whether it is well to introduce students to such a difficult, complex, and imcomplete subject in such a concise, not to say cut and dry form, is a question which the author probably did not feel it necessary to consider. He has, however, by the numerous references throughout the work, and in the table of authorities at the end, done all in his power to put the students in the way of consulting the original works. This is aid of which students will do well to avail themselves, for nothing can equal work from the master's hand, and however carefully the general features may have been studied, the reading of such papers as those of Stokes, Rankine, and Helmholtz cannot fail to shed, what may be called, the light of life over the whole subject.

OSBORNE REYNOLDS

THE INTERIOR OF GREENLAND

Meddelelser om Grönland, udgivne af Commissionen for Ledelsen af de geologiske og geographiske Undersogelser i Grönland. Forst Hefte. (Copenhagen, 1879.)

SO large an amount of interest has been awakened during recent years concerning the nature of the interior of the vast island of Greenland, that the publication of this first instalment of the researches carried on under the auspices of the Danish Government will be

welcomed by geographers and geologists all over the world. The work is written in the Danish language, but a *résumé* in French, by M. F. Johnstrup, enables readers unacquainted with the former language to become possessed of the interesting facts contained in the volume. The work contains four memoirs of great interest: an account of the expedition upon the inland ice, made by Lieut. Jensen in 1878; a record of the astronomical and meteorological observations made during this journey; notes on the geology of the west coast of Greenland, by M. Kornerup; and remarks upon the plants collected by the last named explorer, by M. Lange.

In the year 1870 Prof. Nordenskjold, setting out from the vicinity of Disco Bay in company with Dr. Berggren, was able to penetrate to a distance of thirty miles into the interior, at which point the continental ice was found to attain a height of 2,200 feet. Starting from the neighbourhood of Frederikshaab, in South Greenland, Lieut. Jensen traversed a distance of forty-six miles over the continental ice. Here he found, as did Dalager, who made a similar attempt from the same point in 1751, that a number of islands of rock (Nunatakker) rise above the general level of the great sea of ice, and upon these rocky islets no less than fifty-four species of plants were collected.

The observations of most general interest, however, which were made by this expedition, were those which relate to the condition and movements of the great sheet of ice that covers the interior of the island. We cannot do better than give the *résumé* of these observations, which is furnished by M. Johnstrup; it is as follows:—

1. At a distance of 75 to 76 kilometres from the shore, the continental ice attains a height of 1,570 metres (5,115 feet), and must be of considerable thickness, since its inclination to the east from the Isblink of Frederikshaab averages only 49′.

2. On that part of the continental ice which has been explored even at a great distance from the shore, are found many "Nunatakker," which influence to a great extent the movement of the ice, in some cases actually bringing about a reversal of the direction.

3. The surfaces of dislocation resulting from the movement of the ice are almost vertical in the midst of the continental ice, but they incline at the edge and near the "Nunatakker," where the slope of the ground is great, and the upper parts of the ice, in consequence, move more rapidly.

4. The crevasses are partly perpendicular, partly parallel to the direction of the movements, following the nature of the inequalities of the rocky bed, and in places where the ice takes a fan-like disposition, both radial and tangential crevasses are observed.

5. Around the "Nunatakker" and the rocks near the shore, the surface of the continental ice is impregnated with fine rocky *débris* (sand and clay) which are brought there by tempests, and which brooks carry from a distance to the cavities of the continental ice. The masses of clay thus collected give rise to the pyramids of ice which near the Isblink of Frederikshaab, attain an elevation of nearly 60 feet.

6. Moraines of different form are found on the continental ice, especially near the "Nunatakker," and they must be referred to the classes of ground "moraines and terminal" moraines. They frequently form curved or semi-circular lines, and inclose well rounded masses of stone of no great magnitude, which in their advance fall into the crevasses.

Next in interest and importance to the investigations upon the continental ice of Greenland, we must regard the new facts on the geology of the few portions of the country uncovered by the great ice mantle, with which this work furnishes us. A geological map of the West Coast of Greenland from Godthaab to Tingingnertok shows the rocks exposed along the coast and in the islets which rise above the great ice-sheet to be mostly composed of gneiss with some mica-, talc-, and hornblende-schists, and occasional patches of granite.

New proofs of the gradual elevation going on in past times on the West Coast of Greenland are furnished in the work before us. Five sets of raised-beaches are described occurring at heights of 28, 57, 94, 192, and 326 feet above the sea-level respectively. On the other hand there is clear evidence that the land is, at the present time, slowly subsiding, the extent of this movement being shown to have been at Lichtenfels from 6 to 8 feet since the year 1789.

The work we have been noticing is illustrated with several valuable maps and plates, together with numerous woodcuts; and the succeeding parts will be looked forward to with much interest by those who desire to know more concerning that veritable *terra incognita*, the interior of Greenland.

OUR BOOK SHELF

A History of the Tin Trade. By P. W. Flower. (London: George Bell and Sons, 1880.)

THE author, who is well known as one of the largest manufacturers of tin plates, and also as having introduced into this country the French method of decorating tin plates by lithographic printing, has in this volume collected numerous interesting facts in connection with the early history of the manufacture in South Wales, and, what is of more value, has reprinted those parts of the scarce work of Andrew Yarranton, "England's Greatness," 1677, that refer to his journey into Saxony for the purpose of learning the method of tinning sheet-iron. With these are associated extracts from other not very well known works, translations of the accounts of tin-plate making published at various times in the last century by Réaumur, Diderot (in the "Encyclopédie") and Jars, and those of Parkes, 1818, and Ebenezer Rogers, 1857, the latter from the *Transactions* of the South Wales Institute of Engineers. No notice, however, is taken of the later and more complete account published in Percy's "Iron and Steel." An introductory chapter on the metallurgy of tin, and a subsequent one on the modern manufacture of tin plate, are exceedingly feeble. The former is derived from such sources of information as Dodd's "Manufactures in Metal" and the "Beauties of England and Wales," and the latter, though containing matter that may interest those who are acquainted with the details of the process, will not convey much information to those who are not. The final portion of the volume deals with economic details and statistics; the latter of some elaboration, but from four to six years after date, and the prices in different European seats of manufacture are represented by prices current in 1872-73-74. There are several curious errors which can scarcely have been expected to be found, as, for instance, the "Lamb and Flag" brand on tin ingots is said to be the stamp of the